Accelerator Physics and Commissioning

Mike Syphers

Introduction

Accelerator Physics Efforts

Commissioning Efforts

Summary/Conclusions

AP & C Activities

- Accelerator Physics

  Topics affecting upgrade path for LHC …

  – Electron Cloud (*via* M. Furman, LBNL)
  – Interaction Regions & Beam-Beam (*via* T. Sen, FNAL)

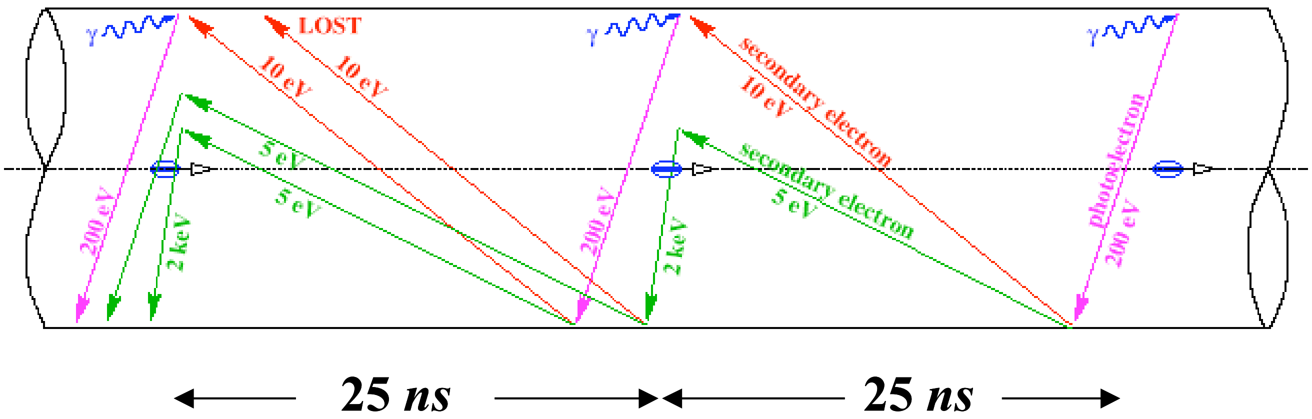
- Commissioning

  In addition to other deliverables (*e.g.*, instrumentation) …

  – Interaction Region Commissioning (*via* M. Lamm, FNAL)
  – Beam Commissioning (*via* E. Harms, FNAL)

The Electron-Cloud Effect in LHC

M. Furman



- Beam synchrotron radiation is important
  – provides source of photo-electrons
- Secondary emission yield (SEY) $\delta(E)$ is important
  – characterized by peak value δ_{max}
  – determines overall e^- density
- e^- reflectivity $\delta(0)$ is important
  – determines survival time of e^-
- Bunch intensity *N* and beam fill pattern are important
- Main concern: power deposition by electrons

e-Cloud Recent Developments

LARP

- RHIC (*)
  - CERN e^- detectors for IP12
    - to be shipped and installed starting July 2005
    - testing and calibration during 2006 run
    - two dipole magnets, $B \leq 0.2$ T (one detector/dipole)
    - change in design: RT, not cold region
  - Proposal of ion detector (ionization profile monitor)
    - ionization of residual gas? possible e^- trapping?
  - e-cloud maps: paper published PRST-AB (Iriso-Peggs)
  - Active search for student or post-doc to replace Ubaldo Iriso
- CERN
  - New analysis of SPS data (D. Schulte & F. Zimmermann):
    - peak SEY δ_{max}~1.4 and e^- reflectivity R~0.5 are good solution to fits
  - Cryo pumping available for e-cloud power deposition re-estimated: ~0.2 → ~2 W/m (!)
  - Bug in ECLOUD code found and fixed: need δ_{max}<1.3 at LHC arcs to not exceed 2 W/m
  - Earlier large ion density observations at SPS: gone (detector artifact)

(*) RHIC e-cloud activities not all funded by the LARP program

e-Cloud Recent Developments (contd.)

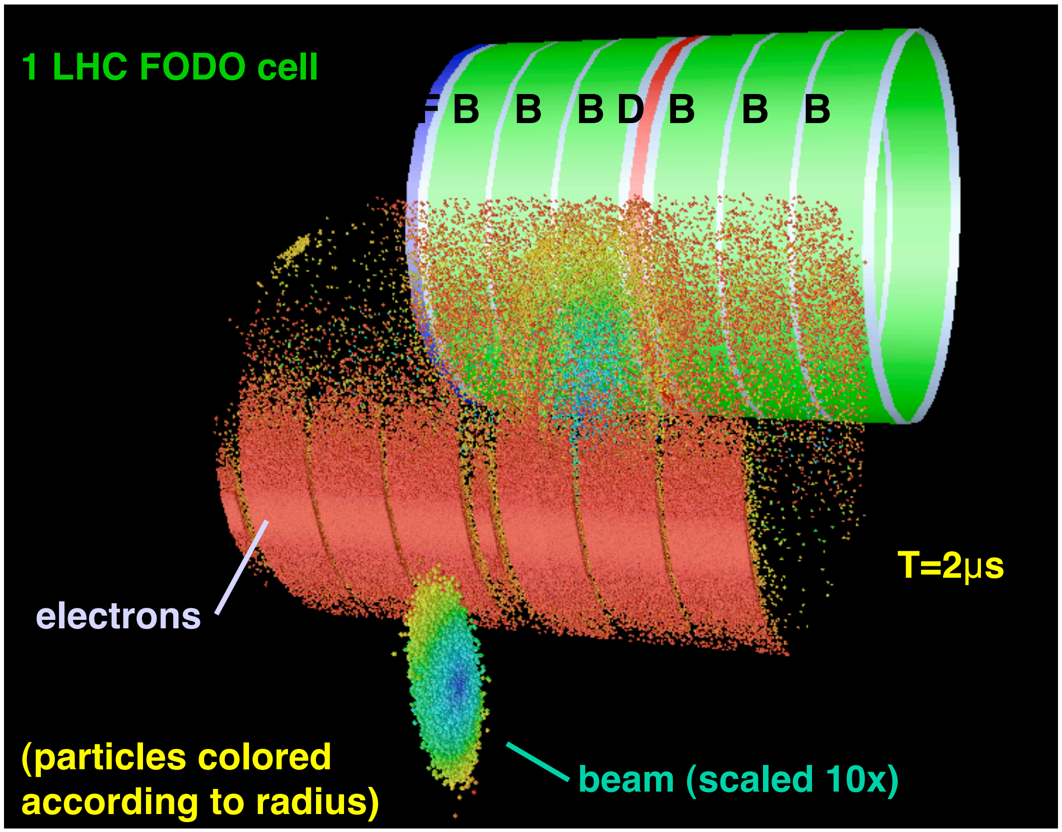
LARP

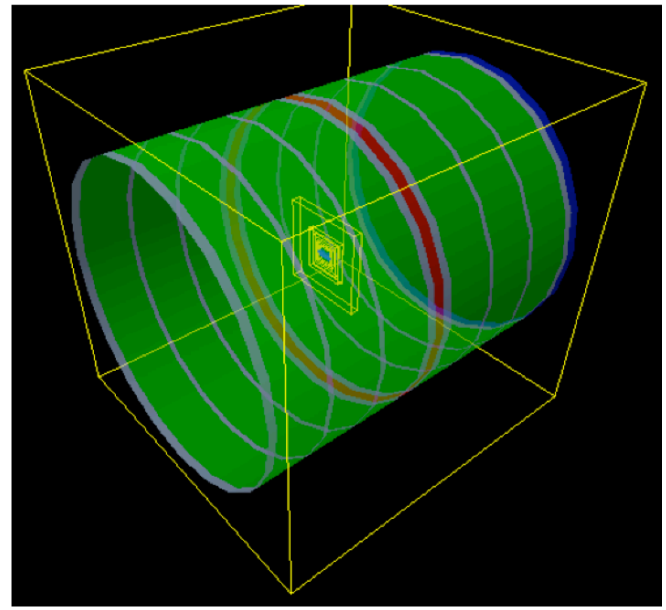
- LBNL
  - Simulations for SPS runs (summer '04) continue (M. Furman, M. Pivi)
    - e-cloud effect much less for 75 ns bunch spacing than 25 ns
    - other detailed comparisons against CERN simulations (code ECLOUD) starting
    - a first 3D, self-consistent, e-cloud simulation of LHC FODO cell: new code(*)
  - Participation at HHH2004 (M. Furman, Nov. 2004)
    - discussions on e-cloud codes
    - some SPS measurements clarified, more plans for LBNL simulations
  - Trip to CERN March 21-25, 2005 (M. Furman and Ji Qiang)
    - discussions on e-cloud and str-str-BB
    - feedback from CERN people on our plans
    - status of CERN work
  - Summer student has been made an offer
    - to start in early June 2005 for 10 weeks
    - total student cost: $5k
    - possible tasks (TBC): a) simulate LHC power deposition; b) SPS σ_z dependence; c) simulate RHIC e-cloud detectors

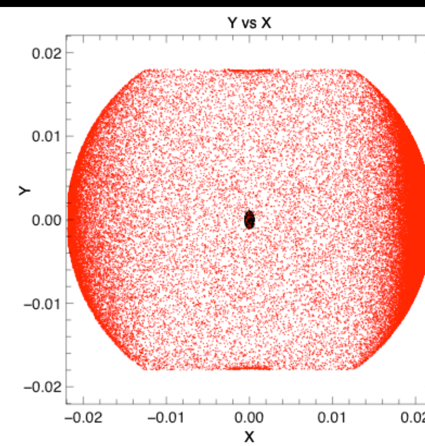
(*) So far funded (at ~90% level) by LDRD

Application of a New 3D e-Cloud Code to LHC

M. Furman, J.-L. Vay: (WARP+POSINST)







- AMR provides speedup of x20,000 on field solve

Movie... ***(Jean-Luc Vay)***

e-Cloud Goals

- Complete the analysis of June 2004 SPS run (*) (LBNL, FY05)
  - especially e^- energy spectrum
  - goal: constrain SEY model for better predictions for LHC
- Additional SPS studies: σ_z dependence (LBNL, FY05-06)
  - "confusing" lack of correlation between simulations and observations
- LHC heat-load estimate: POSINST-ECLOUD benchmarking (*) (LBNL, FY05-06)
- Report first cut at defining optimal LHC conditioning scenario (LBNL, FY06-07) (*)
  - define optimal fill pattern during first two years of LHC beam ops.
- Further 3D simulations for LHC arcs (LBNL, FY06-07) (*)
  - bunch trains, beam instability
- Report on applicability of Iriso-Peggs maps to LHC (BNL, FY06-07) (*)
  - understand physics of map simulation technique
  - understand global e-cloud parameter space, phase transitions
- Report on e-cloud simulations for RHIC detectors (BNL, FY06-07) (**)
  - calibrate code, then predict BBB tune shift
- Report on e-cloud simulations for LHC IR4 "pilot diagnostic bench" (LBNL, FY07+)
  - have some idea what to expect when high-N beam turns on

(*) strongly endorsed by CERN AP group (communicated by F. Ruggiero and H. Schmickler)

(**) strongly endorsed by CERN vacuum group (communicated by J. M. Jiménez)

Budget Discussion -- Electron Cloud

- All above tasks, if funded, would be: 2.4 FTE for FY06, 2.4 FTE for FY07 (LBNL & BNL combined)
- Allocated for FY06: 1.0 FTE; includes:
  – 0.25 FTE (BNL) -- LHC-style detector sims.; 0.75 FTE (LBNL)
  – 0.75 FTE (LBNL) -- benchmarking, Iriso-Peggs maps, conditioning scenario

- If more funding were available, would add following tasks to original scope:
  – Validate new 3D code via dedicated simulations/experiments at the LBNL HCX facility (1 FTE FY06, 1 FTE FY07)
  – Understand long survival times of e^- at SPS (0.75 FTE+$25k for each FY06 and 07)
    - evaluate ion trapping mechanism via expts. and simulation
  – Measure gas desorption from stray beam particles (1 FTE+$20k FY06)
    - helps quantify ion cloud density
  – Extend above to NEG coatings (0.5 FTE+$10k FY06)
  – Extend above to cold surfaces (1.25 FTE+$250k FY06)
  – Emulate BIM via RF-driven electrodes on HCX beam (0.5 FTE+$20k FY06)

LARP

BNL -FNAL - LBNL - SLAC

Interaction Region and Beam-beam

T. Sen

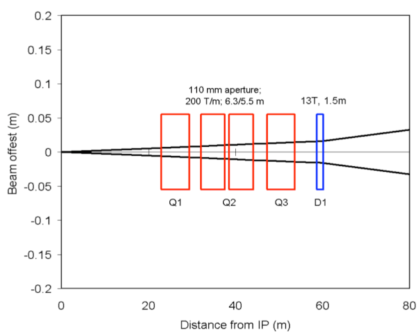
Interaction Region Optics for the Upgrade

Energy Deposition in Interaction Regions

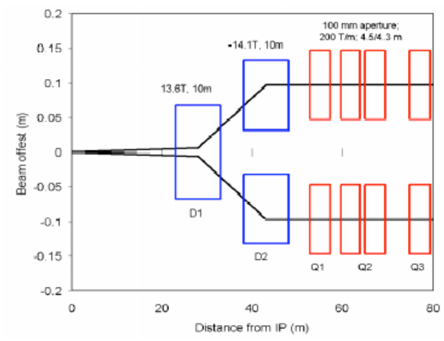
Beam-beam simulations

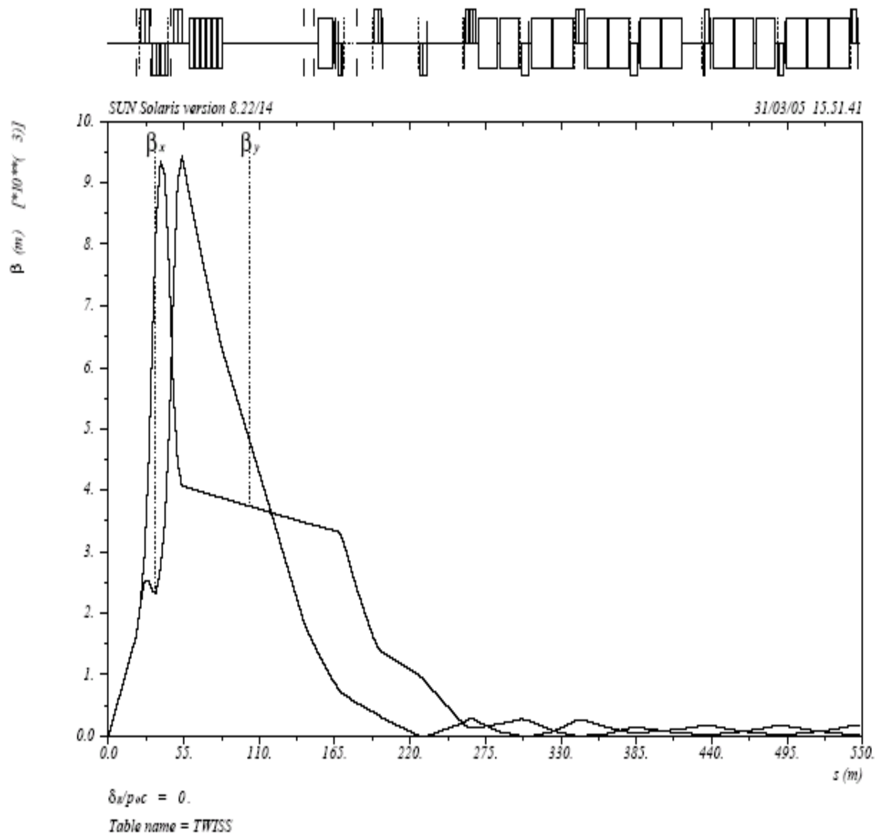
IR Designs for the Upgrade with Triplets

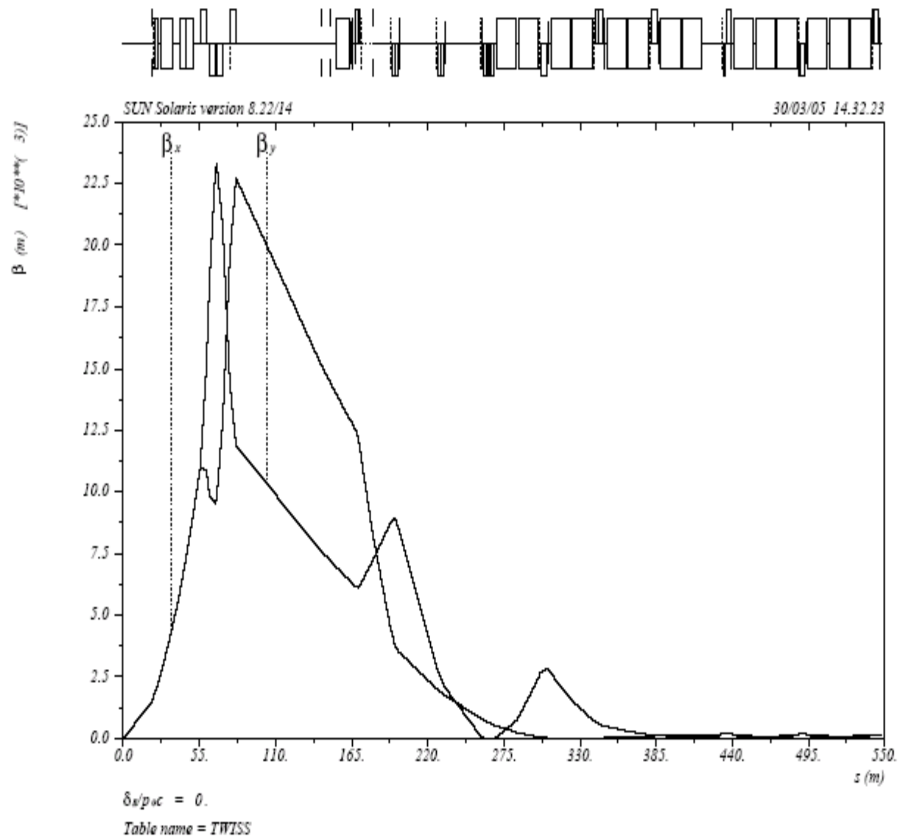
Quadrupoles first



Dipoles first







Optics Features with Quads or Dipoles First

Quads first features

- Focusing starts early, lowers beta function in magnets, simplest upgrade path

But,

- Beams go off-axis in the quadrupoles => feed-down effects, correction algorithm acts on both beams, 15 long-range interactions on either side of IP

Dipoles first features

- Reduces long-range interactions 3 fold, independent nonlinear correction for each beam

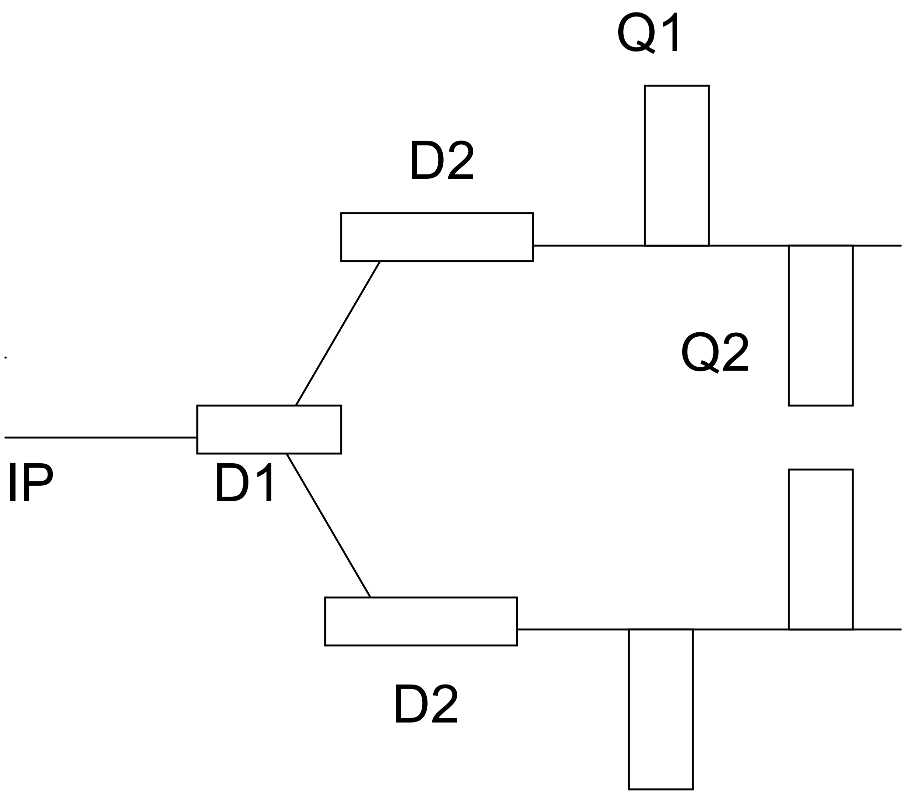
But,

- Larger β^{max} for the same β^* - about 2.5 times larger, higher energy deposition in D1 from charged particles, matching section quads Q4-Q8 will have to be large aperture magnets

β Maximum in Quads

	Quads first β^{max} [m]	Dipoles first β^{max} [m]
Q1	4538	15100
Q2	9193	23036
Q3	9427	22720
Q4	3323	12517
Q5	1559	8859
Q6	984	2791
Q7	285	748
Q8	261	2857
Q9	270	693
Q10	153	162
QT11	181	185
QT12	183	183
QT13	173	172

Dipoles First and Doublet Focusing



Focusing symmetric about IP

Features

- Requires beams to be in separate focusing channels
- Fewer magnets
- Lowers IR chromaticity
- Beams are not round at the IP
- Polarity of Q1 determined by crossing plane – larger beam size in the crossing plane to increase overlap
- Significant changes to magnets in matching section.

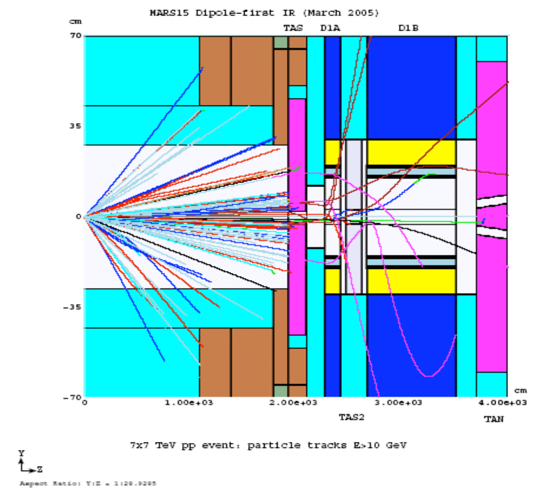
Energy Deposition in Open Mid-Plane Dipole

Strong ties to Magnet program…

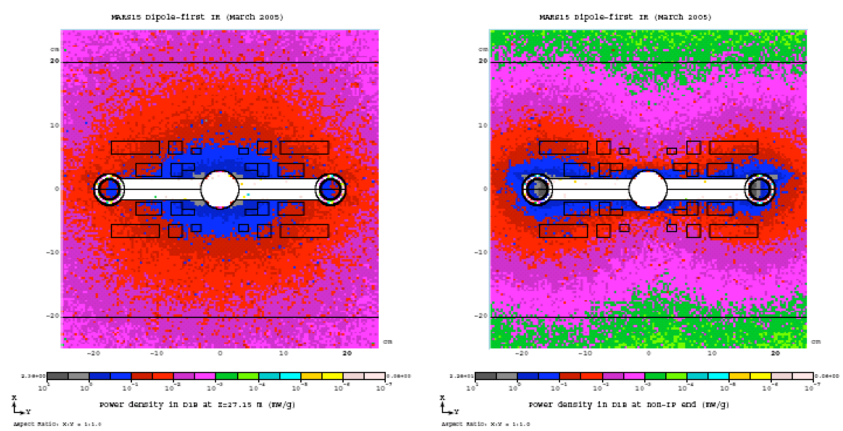
Optimized Dipole with TAS2

- IP end of dipole is well protected. Magnetized TAS1 is not feasible – estimated field of 20 T-m
- Instead, split D1 into 2 dipoles D1A, D1B, Spray from D1A is absorbed by additional absorber TAS2.
- Results
  - ➢Peak power density in SC coils is below the quench limit with a safety margin
  - ➢Heat load to D1 is drastically reduced
  - ➢Other radiation issues are mitigated, e.g. estimated lifetimes higher

DIPOLE-FIRST IR of MARCH'05: ONE PP-EVENT



POWER DENSITY AT TWO LONGITUDINAL MAXIMA



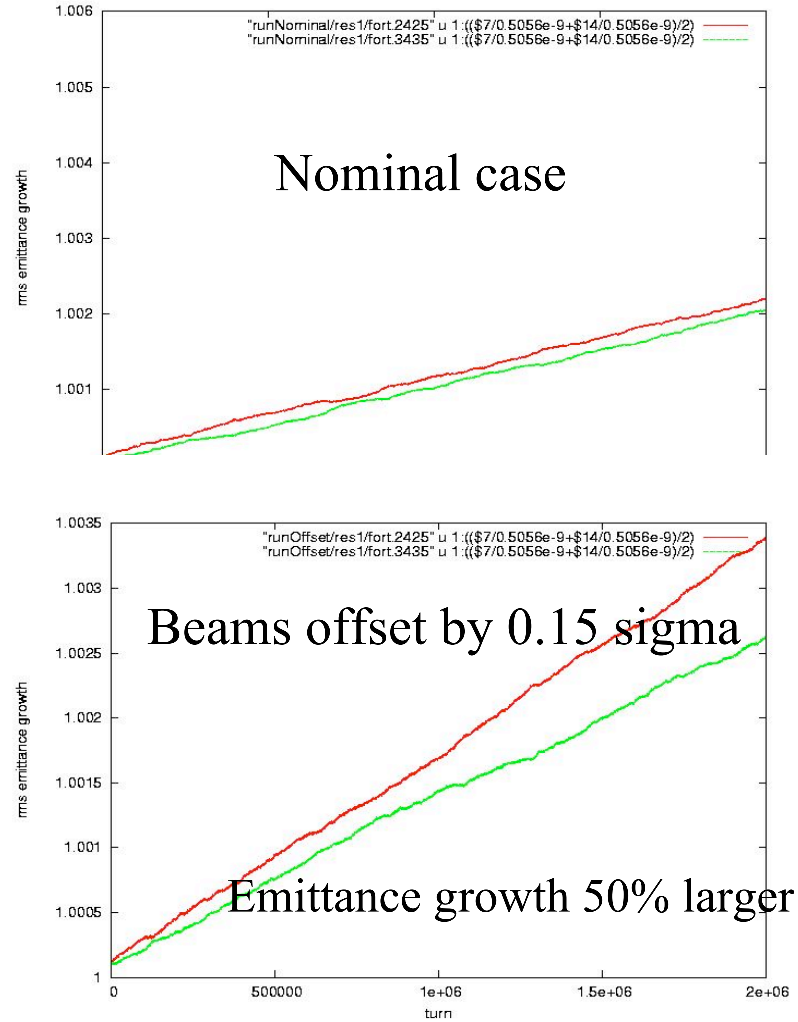
Peak power density in SC coils ≤ 0.7 mW/g, below the quench limit with a safety margin!

LARP

Strong-Strong Beam-Beam Simulations

- Strong-strong simulations done with PIC style code Beambeam3D (LBNL)
- Emphasis on emittance growth due to head-on interactions under different situations
- Beam offset at IP
- Mismatched emittances and intensities

- Numerical noise is an issue – growth rate depends on number of macro-particles, *M*. Continuing studies to extract asymptotic (in *M*) growth rates.
- Continuing additions to code: crossing angles, long-range interactions



IR and Beam-Beam Accomplishments in FY05

- **IR Optics design**

  Matched optics for both the quadrupole first and dipole first designs were developed for β^* ~0.25m. Maximum quadrupole gradients of 200 T/m suffice for both designs but larger aperture quadrupoles will be required in the matching section for the dipole first design. The possibility of doublet focusing with the dipole first design was also examined for the first time.

- **Energy Deposition with open mid-plane dipoles**

  The simulations show that the original 10m long dipole should be split into two shorter dipoles, 1.5m and 8.5m long respectively, with an absorber placed between them. These and other modifications lower the peak power density in the superconducting coils to below the quench limit with a safety margin, drastically reduce the heat load to the dipoles and mitigate other radiation issues.

- **Beam-beam simulations**

  A strong-strong code was used to study emittance growth with the head-on interactions. Situations such as beam offsets, emittance and intensity mismatches that are likely to lead to emittance growth were studied.

- **Papers**

- "Overview of possible LHC IR layouts", Proceedings of CARE-HHH conference, CERN November 2004.
- "Beam-beam simulations of hadron colliders", Proceedings of CARE-HHH conference, CERN November 2004.
- Wire compensation experiments at the SPS in 2004, PAC05

Expected Accomplishments in FY05-06

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- **IR Optics Designs**

  Design concepts for the IR upgrade will be explored in greater detail. Matched designs that can be used from injection to collision will be developed. These designs will be developed in collaboration with magnet designers at BNL, FNAL and LBL.

- **Energy deposition**

  Further development of the MARS code, including upgrade of the geometry, visualization, heavy ion and electromagnetic shower modules. Energy deposition calculations will continue for IR1 and IR5 regions at normal operation and accident conditions

- **Beam-beam simulations**

  Continuing development of the Beambeam 3D code. Application to halo formation, luminosity monitor (swept beams).

- **IR and Beam-beam Workshop**

  A workshop focused on IR design concepts, beam-beam compensation and the feasibility of crab cavities will be held near FNAL, October 5-6, 2005

LARP

IR and Beam-Beam Tasks -- FY06-07

- **IR Optics designs**
  - Quad first – lowest feasible β^* consistent with gradients and apertures, field quality
  - Dipoles first – Triplet: β^*, apertures, gradients, field quality
  - Dipoles first – Doublet focusing: explore feasibility

- **Beam-beam simulations**
  - Strong-strong beam-beam simulations: emittance growth with swept beams (luminosity monitor), wire compensation, and halo formation (Beambeam3D)

- **Energy Deposition**
  - For different IR designs (quadrupole and dipole first), tertiary collimators, and the forward detector regions (CMS, TOTEM, FP420 and ZDC).

LARP

Level of Effort in FY06-07: IR & bb

	BNL FTEs	FNAL FTEs	LBL FTEs
IR design	-	1*	-
Beam-beam simulations	-	-	1*
Energy deposition	-	1*	-

* - requires new post-doc hire

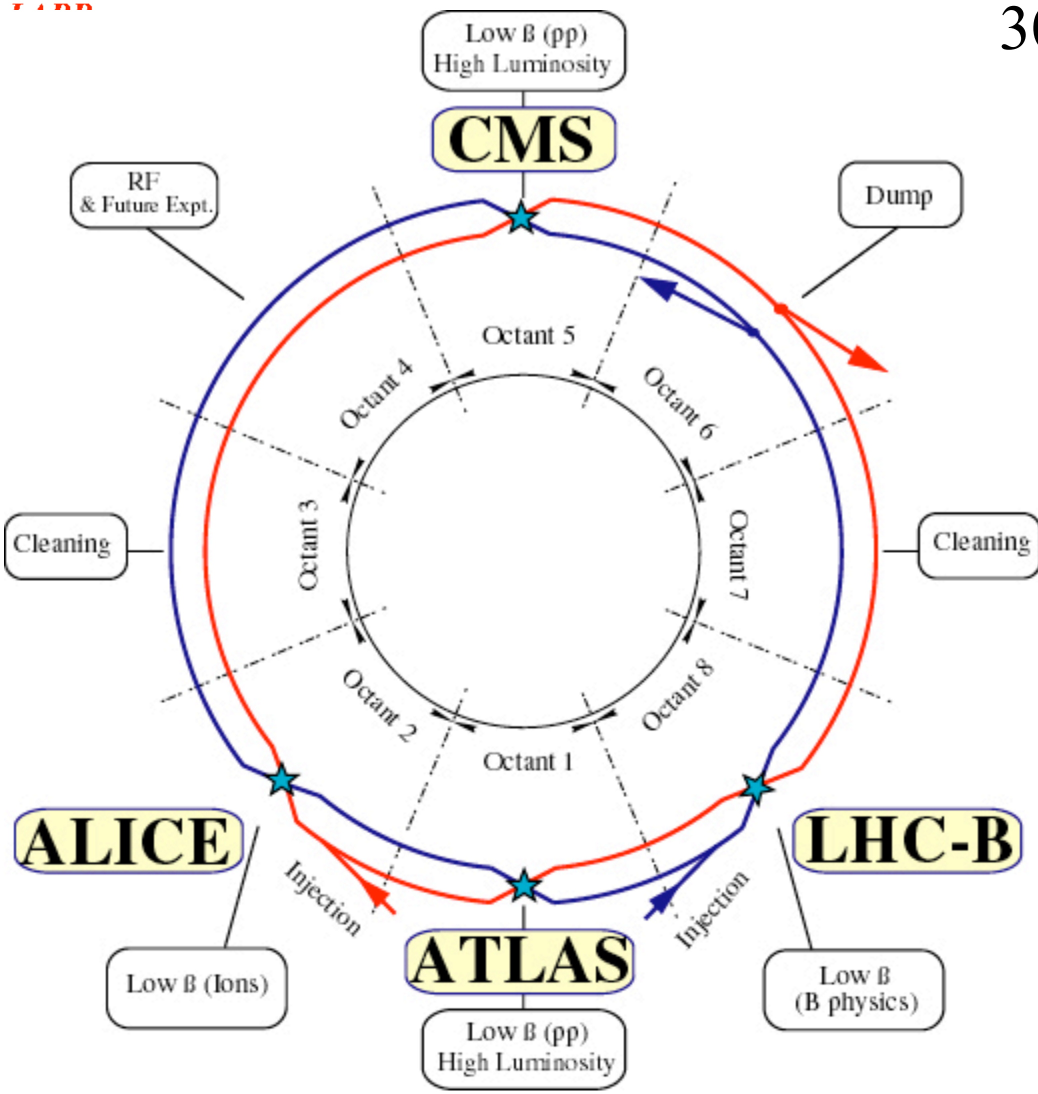
Wire Compensation Proposal

T. Sen

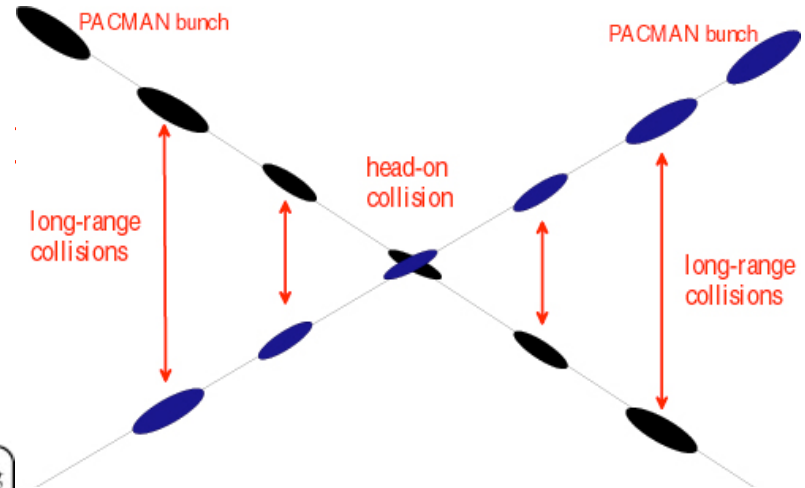
Possible new LARP task…

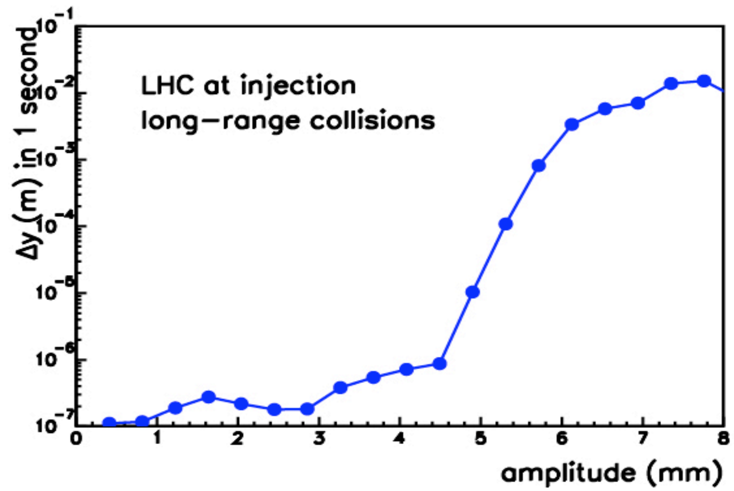
- ***Motivation for compensation***
- ***Results of SPS experiments***
- ***Beam-beam experiment at RHIC***
- ***Proposal***

Motivation for Compensation



30 long-range collisions per IP





Long-range interactions enhance diffusion. Tevatron experience

SPS Wire Experiments 2004

F. Zimmermann (CERN)

One beam, two wire compensators BBLR1 and BBLR2. BBLR2 installed in 2004

Studies in July, August, September, November 2004

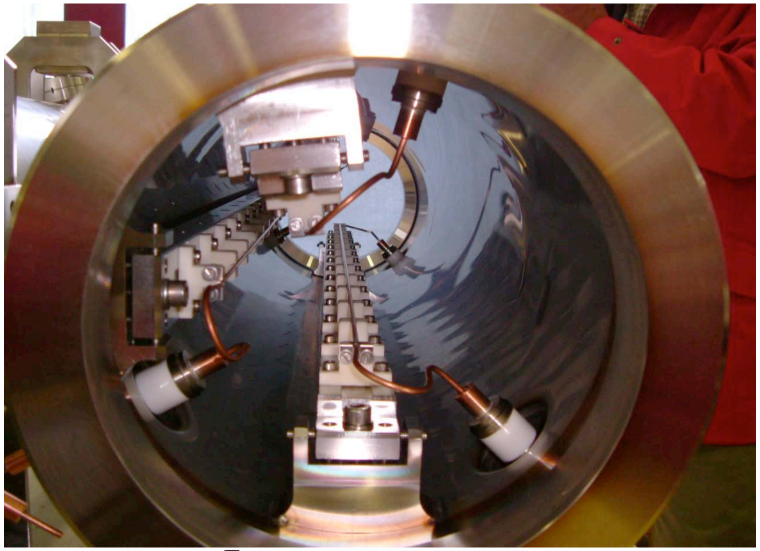
FNAL LARP participated in July and November studies

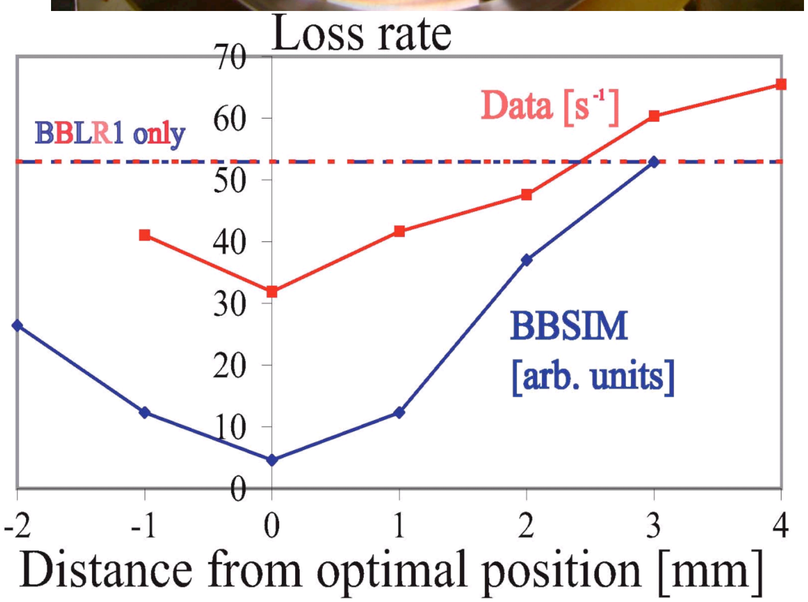
Tested: relative alignment, current tolerance, tune sensitivity and different crossing planes.

<u>Prediction</u> of relative alignment tolerance of the 2 wires with BBSIM (FNAL weak-strong code)

Main observation: Compensation of one wire by another worked well in LHC conditions

Simulations: in general good agreement with observations



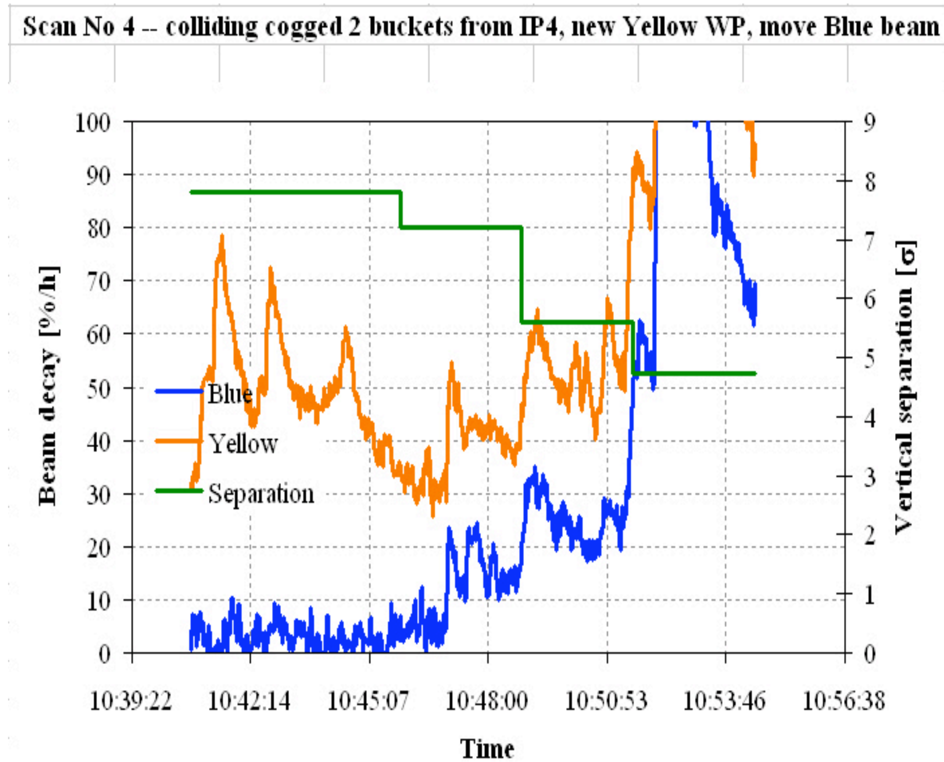


PAC05 paper: MOPC009

RHIC Beam-Beam Experiment

W. Fischer (BNL)

<u>Phase 1 study</u> – April 28, 2005
FNAL LARP participation (remotely from FNAL)
Goal: Study lifetime. and losses as beam-beam separation is varied



Observations:

- Onset of significant losses for separations below 7σ
- Phenomena is tune dependent

•Tunes of blue and yellow beam symmetric about diagonal

•Losses in both beams increase with decrease in separation; impact even at ~7 sigma

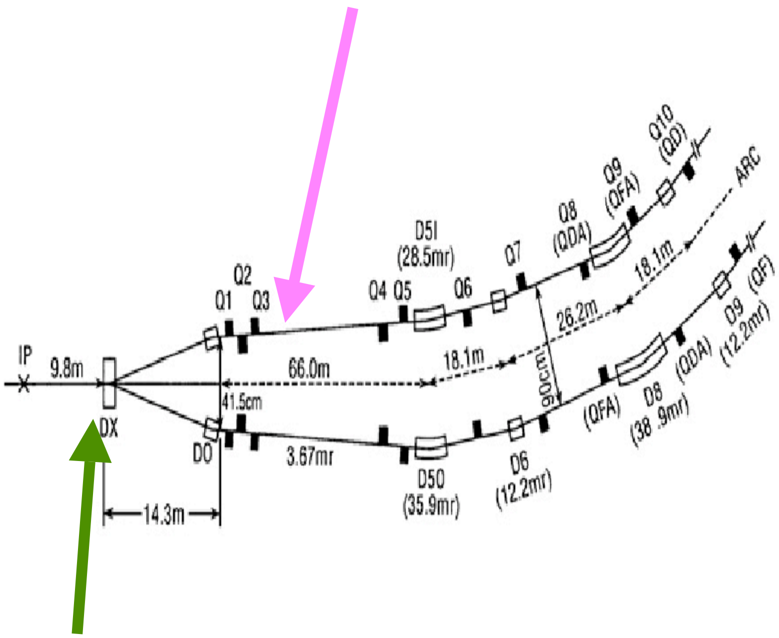
LARP

Wire Compensation Proposal

RHIC IR

Phase advance from parasitic to wire = 6^o

Possible location of wire



Parasitic interaction

RHIC provides unique environment to study experimentally long-range beam-beam akin to LHC operation

Proposal:

Install wire compensator in RHIC in summer 2006, downstream of Q3 in IR6

Budget Requested for FY06: $230K (*Note: $180K more likely*)

<u>Statement of work for FY06:</u>

- Design and construct a wire compensator (either at BNL or FNAL)
- Install wire compensator on a movable stand in one of the RHIC rings
- Theoretical studies (analysis and simulations) to test the compensation and robustness
- Beam studies in RHIC with 1 proton bunch in each beam and nominal conditions at flat top and 1 parasitic interaction. Observations of lifetimes, losses, emittances, tunes, orbits for each beam-beam separation.
- Beam studies to test tolerances on: beam-wire separation compared to beam-beam separation, wire current accuracy, current ripple

Wire Compensation Proposal -- Task Sheet

LARP Task Sheet has been generated, and agreed upon by FNAL and BNL

T. Sen, FNAL

W. Fischer, BNL

and is awaiting approval by LARP management…

US LHC Accelerator Research Program
Task Sheet

Task Name: Wire compensation of beam-beam interactions   Date: 23 May 2005

Responsible person (overall lead, lead at other labs):
Tanaji Sen (FNAL, lead), Wolfram Fischer (BNL)

Budget for FY06: $230K

Statement of work for FY06:

1) Design and construct a wire compensator (either at BNL or FNAL)
2) Install wire compensator on a movable stand in one of the RHIC rings
3) Theoretical studies (analysis and simulations) to test the compensation and robustness
4) Beam studies in RHIC with 1 proton bunch in each beam and nominal conditions at flat top and 1 parasitic interaction. Observations of lifetimes, losses, emittances, tunes, orbits for each beam-beam separation.
5) Beam studies to test tolerances on: beam-wire separation compared to beam-beam separation, wire current accuracy, current ripple

Statement of work for FY07:

1) Beam studies with elliptical beams at the parasitic interaction, aspect ratio close to that of the beams in the LHC IR quadrupoles
2) Compensation of multiple bunches in RHIC with pulsed wire current. Requires additional voltage modulator

Budget details for FY06
Materials: Wire compensator - $100K, Movable stand - $30K
The decision to build the compensator either at BNL or FNAL will be made depending on cost, manpower availability, and overall best fit to the task.
BNL labor charges: $50K (W. Fischer and student)
FNAL labor charges: $50K (T. Sen and post-doc)

Budget estimate for FY07
Materials: Cost of voltage modulator
Labor charges: $50K (BNL), $50K (FNAL)

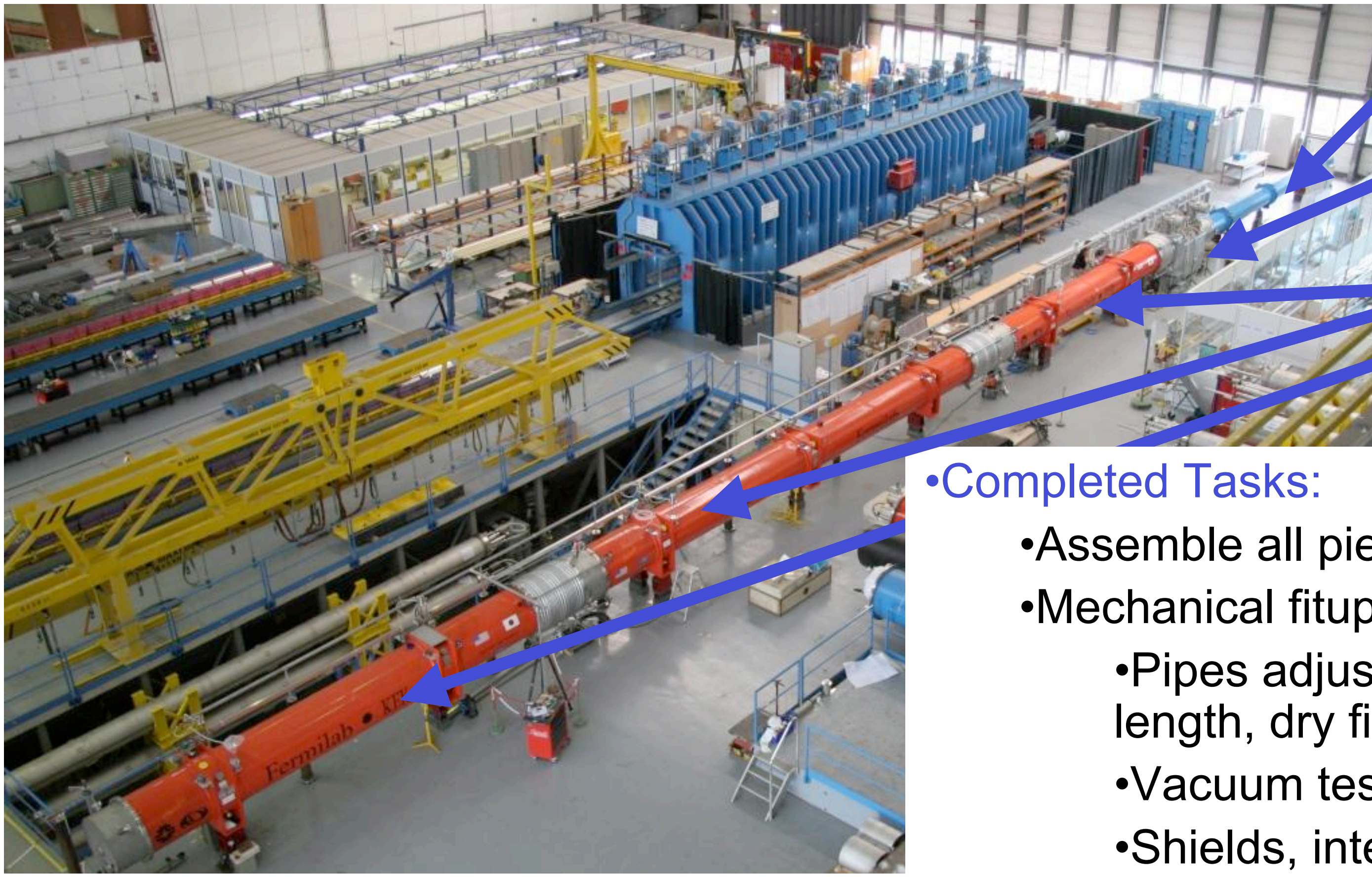
CERN Contacts
J.P. Koutchouk, F. Zimmermann

Interaction Region Commissioning

M. Lamm

- Above Ground Mechanical Fitup
- Installation Oversight and
- Hardware Commissioning of US Deliverables

Successful Above Ground Fitup of US Deliverables LHC Assembly Building March-April 2005



- D1 (BNL)
- DFBX (LBNL)
- Inner Triplet (FNAL)

- Completed Tasks:
  - Assemble all pieces for complete IR
  - Mechanical fitup of interconnects
    - Pipes adjustments to install length, dry fit
    - Vacuum tests
    - Shields, interconnect kits
  - Magnets on alignment jacks
  - Electrical continuity

Participants: Joseph Rasson (LBNL), Rodger Bossert, Joe Dimarco, Phil Pfund, Tom Page, Tom Nicol, Jim Rife, Michael Lamm (FNAL)

(2) Installation

- Time Frame: First sector Fall 2005, throughout FY2006, 07?
  - Check mechanical/vacuum/cryo connections
  - Check installation procedures
  - Review electrical and alignment data
  - Installation bugs worked out in Mechanical Fitup
- Level of Effort FY06-07
  - ~1/3 FTE on First sector
  - Less on subsequent sectors (but non zero based on fitup)
- Main TD Participants
  - Mechanical Engineers (Rasson, Page, Nicol, Bossert, Plate….)
- Main CERN Contacts
  - Ranko Ostojic AT-MEL and Interconnect team in AT-CRI

(3) Commissioning

- Start Fall 2005 (US Deliverables first in LHC to be commissioned!)
  - Participation at first through short visits and possibly through remote monitoring
- Full Commissioning Task Starts Spring 2006
  - We are lining up people to live at CERN in CY 2006
    - Cryogenic Expert
      - Experienced in Superfluid testing of US Magnets
    - Magnet Physicist Magnet powering, quench protection
- Expected Hardware Commissioning completion in Summer 2007
- Small carryover into beam commissioning to study dynamic heat loads on magnets and cryosystem

Budget Request for FY06-7

- Effort is 2-3 FTE's /Year
- Cost is Labor + Salary and Living Expenses

	FNAL	BNL	LBNL	Totals	
FY06	370	80	90	**540**	K$
FY07	470	50	165	**685**	K$

- FY06 numbers are lower by ~$150K from original estimates;
  - Assumes some costs deferred to FY07

Conclusions -- IR Commissioning

- IR HC is an important way for the US to contribute to the LHC project
  - Inner triplet HC contribution is established
  - Recent new requests in global commissioning could greatly expand our role
- Our participation in Inner Triplet Region is limited by funding and ongoing US commitments
  - We could do more.
- Taking responsibilities in Inner Triplet Region (an area in which the US has a large and unique expertise) could help in the other HC (free up CERN personnel, LARP IR personnel can take on global jobs) if pursued.
- Major uncertainties are being addressed:
  - Uncertainty in CERN schedule (real schedule now available)
  - Lining up the appropriate people at the right time (so far so good)

Beam Commissioning

E. Harms

Introduction

Recent Accomplishments

Expected Accomplishments for FY05

Vision for Tasks and Budget for FY06-07

Summary/conclusion

Introduction

- Beam commissioning has been one of the cornerstones of LARP since its inception. U.S. involvement in LHC beam commissioning was originally envisioned to include the presence of at least one U.S. accelerator scientist on each LHC commissioning shift.

- The structure and tasks of such a presence has evolved. It is currently envisioned that US LARP participation will be as part of Commissioning teams consisting of both CERN and US scientists and engineers. The teams will focus on specific tasks as part of the entire commissioning process.

- The list of tasks/teams in currently under development at CERN. Once the prioritized list is received it will be reviewed and potential US candidates will be plugged in where vacancies and abilities lie.

LARP involvement – CERN perspective

- In the present US-LARP proposal, resources are allocated for "Beam Commissioning" activities from 2004 onward, rising to more significant numbers by 2007.
  - US-LARP commitment has to include long-term individual commitments of around 12 months
  - US staff should go to CERN to perform a specific role in the beam commissioning work. It has also been clearly said that CERN has to maintain sufficient expertise, particularly on shift, to ensure long-term exploitation of the machine
- With this in mind, it is felt that a very limited number of US-LARP resources could participate in the shift *rota*. Rather, they would be best suited to the accelerator physics and equipment group support activities

Accelerator Systems and Responsibilities 1

	System		Equipment Group	Beam Physics or Operational aspects
Systems needed pre beam	Control system			
	Applications software			
	Accelerator technical services	TI operations		
		Electrical supply		
		Cooling & Ventilation		
	Vacuum			
	Cryogenics			
	Access			
	Cold magnets			
	Warm magnets			
	Magnet circuits and power converters			
	Power Interlock System (PIC)			
	Quench Protection and Energy Extraction (QPS)			

We know who these are

No or very few names here

- Points to address for each system
  - What is the specification with beam
  - What measurements are needed
  - What tools are needed
  - What beam is needed
  - How much time is needed

This is the meat of Hardware Commissioning

from Roger Bailey

Accelerator Systems and Responsibilities 2

	System		Equipment Group	Beam Physics or Operational aspects
Systems needed for beam	SPS extraction, transfer, injection and first turn			
	Multi turn losses and BIS dependability			
	Protection devices other than collimators			
	Collimation system and Halo cleaning			
	Clean Beam Extraction			
	Radio protection			
	Beam Instrumentation	Screens		
		BCTs		
		BPM, trajectory & orbit correction		
		BLM		
		PLL for Q, Q', coupling		
		Profile monitors		
		Schottky		
		Luminosity monitors		
	Vacuum conditions during operation and electron cloud			
	Reference magnet system			
	RF systems and longitudinal beam dynamics			
	Transverse feedback			
	Experimental solenoids and compensations			
	Experimental equipment (Roman pots, velo)			

We know who these are

CERN AP interest known here

from Roger Bailey

LARP

Accelerator Systems and Responsibilities 3

	System	Equipment Group	Beam Physics or Operational aspects
Beam based systems	Beam in the injectors		
	Ion beam in the injectors		
	Orbit feedback system		
	Filling efficiency and flat bottom conditions		
	Ramp and squeeze losses and overall quality		
	Machine protection system		
	Optics		
	Mechanical aperture		
	Machine Impedance and collective instabilities		
	Dynamic aperture		
	Lattice corrector settings		
	Triplet corrector settings		
	Lifetimes		
	Separation schemes		
	Crossing angle schemes		
	Collisions and luminosity steering		
	Experimental conditions		
	Ions		

No or very few names here

CERN AP interest known here

from Roger Bailey

Accelerator Systems Support

- All accelerator systems have to be commissioned and will subsequently require expert support to maintain performance at the required level. For this we will obviously count on the equipment groups who are presently building the hardware systems, but we will also need a number of accelerator physicists to assume responsibility for the beam physics aspects

- Three categories of accelerator systems:
  - Predominately equipment systems (such as magnet circuits and power converters) requiring little accelerator physics support
  - Essentially beam-based systems (such as the machine aperture) requiring a lot of accelerator physics support
  - All the rest, requiring both equipment and accelerator physics expertise

- For the accelerator physicists the term responsibility here means:
  - Ensure beforehand that the system specification is clear and that all necessary tools, including software, are in place for first beam or when required
  - Ensure that the system performs to specification as far as the beam is concerned. This will entail ensuring that all the necessary beam measurements are performed during commissioning and that any necessary corrective actions are implemented. All this should clearly be done in close collaboration with the central commissioning team described above
  - ***Provide a link to the LARP personnel associated with the system***

from Roger Bailey

LARP

Recent Accomplishments

- CERN accelerator complex largely off from the fall 2005 through spring 2006; little actual beam activity, but activity nonetheless:
  - October ’04: expected participation in (very successful) TI8 commissioning; LARP participation curtailed by schedule conflicts and illness
  - January ‘05: U.S. personnel were present at CERN for the ‘Chamonix’ workshop
  - March ’05: visit by US personnel to review/discuss list of tasks, plan for CERN staff visits to Fermilab, remote data sharing
  - Spring/Summer ’05: series of visits to Fermilab by CERN/LHC operations staff to partner laboratories
    - build relationships
    - explore possibilities for Remote Monitoring
    - discuss LHC/OP task list

Expected Accomplishments for FY05

- It is hoped that a clearer understanding of where the U.S. can participate in LHC beam commissioning will begin in short order. The abovementioned ‘task lists’ are seen as critical for further progress.
- A long-term presence cannot begin just before first beam; resources need to be allocated to provide for an incremental increase as hardware commissioning begins.
- In order for CERN operations staff to begin to experience operation of a superconducting accelerator a series of 6-week visits by LHC shift commissioners is in progress and will continue into the summer.
- There is a growing interest in LARP beam commissioning and a commensurate virtual change in size of the LARP contingent.

Fermilab Remote Operations Center

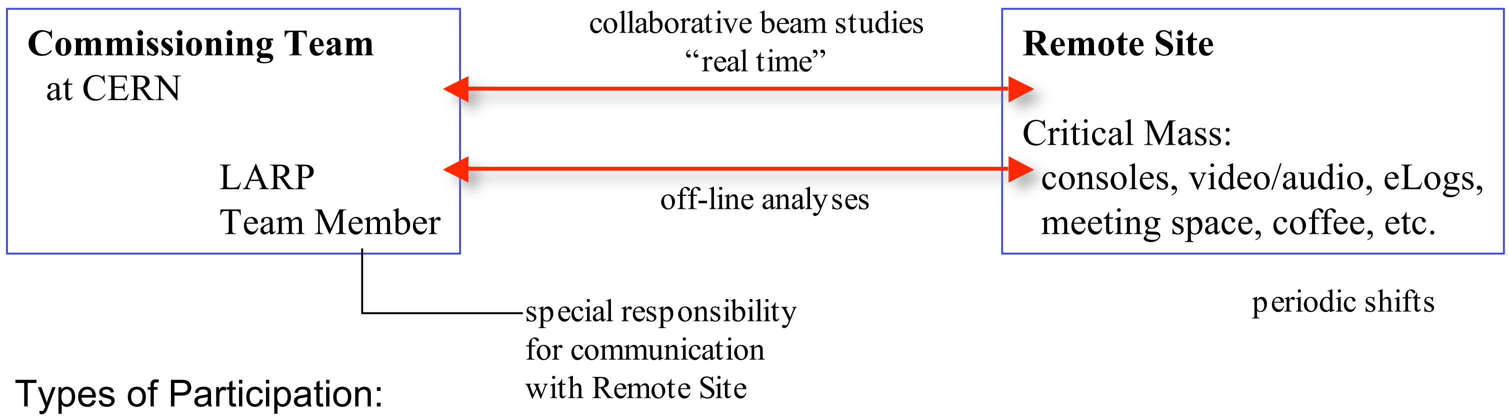
LARP

***Point of Interest*:** A Committee has been charged by the Fermilab Director with constructing a plan for a Fermilab Remote Operations Center

- Define the high level requirements for a Remote Operations Center for CMS, LHC accelerator operations, and US/LHC magnet commissioning
- Develop cost and schedule estimates for the implementation of a Remote Operations Center
- Preliminary report by the end of July, 2005 describing requirements and scope.
- Final report including a Resource Loaded Schedule is due by the end of CY2005.

• While not funded by LARP, will become essential for LARP personnel interaction with LHC commissioning

Types of Participation



Four Types of Participation:

1) Deliverables

person builds something, visits to install, debug, etc., then leaves; may need remote access

2) On-site Commissioning

person has moved to CERN (for ~1 year, say) and works daily with LHC group

3) 1-on-1 Contacts

person works with a particular person or group located at CERN, with occasional trips to CERN to participate in a study, etc.

4) Remote Participation

person is part of a group at Remote Site, participating daily for shorter time periods

"Training" can be performed at the Remote Site; periodic, shorter trips to CERN working with the "On-site" commissioners; people can continue to work remotely upon return

Vision for Tasks and Budget for FY06-07

While the CERN accelerator complex remains off for the first half of 2006, activities will pick up when the injector complex is re-commissioned and a sector test with beam is performed in fall 2006.

Milestones toward LHC operation

- Hardware commissioning continues – LARP involvement?
- Injector start up
- Sector test
- First beam
- Commissioning

There should be a LARP presence during pre-beam activities (hardware commissioning, sector test, etc) to gain an understanding of LHC controls and operation before beam commissioning is initiated.

Beam Commissioning Summary

There have been Beam Commissioning activities this year
- clarification of US role, activities
- remote operations
- visits

US personnel will be identified as CERN releases its list of expected tasks

Activity should ramp up as Hardware Commissioning begins in earnest and Sector test is carried out

Awaiting input from Commissioning Task Force

AP & C Budget -- FY05-06

US LHC Accelerator Research Program			FY2005					FY2006						
			BNL	FNAL	LBNL	SLAC	TOTAL	BNL	FNAL	LBNL	SLAC	TOTAL		
1	Accelerator Systems													
1.2	**Accelerator Physics and Commissioning**	*Syphers*	31	445	110	0	**586**	410	850	320	0	**1580**	*1420*	*90% #'s*
1.2.1	Commissioning													
1.2.1.1	Beam Commissioning	*Harms*	0	30	0	0	30	150	250	0	0	400	*400*	
1.2.1.2	Interaction Region Commissioning	*Lamm*	18	220	25	0	263	80	370	90	0	540	*540*	
1.2.2	Accelerator Physics													
1.2.2.1	Electron Cloud	*Furman*	13	0	45	0	58	50	0	150	0	200	*120*	
1.2.2.2	Interaction Regions and Beam-Beam	*Sen*	0	195	40	0	235	0	180	80	0	260	*260*	
1.2.2.3(?)	Beam-Beam Wires	*Sen*	0	0	0	0	0	130	50	0	0	180	*100*	

			FY05/actuals			4/30/05		FY2006 -blue sky				
			BNL	FNAL	LBNL	SLAC	TOTAL	BNL	FNAL	LBNL	SLAC	TOTAL
1	Accelerator Systems											
1.2	**Accelerator Physics and Commissioning**	*Syphers*	19	287	71	0	**377**	667	1281	946	0	**2894**
1.2.1	Commissioning											
1.2.1.1	Beam Commissioning	*Harms*	0	12	0	0	12	225	350	0	0	575
1.2.1.2	Interaction Region Commissioning	*Lamm*	11	159	15	0	185	92	381	211	0	684
1.2.2	Accelerator Physics											
1.2.2.1	Electron Cloud	*Furman*	8	0	36	0	44	200	0	535	0	735
1.2.2.2	Interaction Regions and Beam-Beam	*Sen*	0	116	20	0	136	0	500	200	0	700
1.2.2.3(?)	Beam-Beam Wires	*Sen*						150	50	0	0	200

- Allocated budget is roughly half of original “blue-sky” requests (actually, even less than half of the very early requests); interest is there to do more
- If FY06 budget trimmed another 10%, would need to sacrifice work on e-Cloud and Beam-Beam Wires
  – Would not wish to *halt* either; prefer to slow down if necessary
  – These 2 not as “critical” (in the current time line) as others